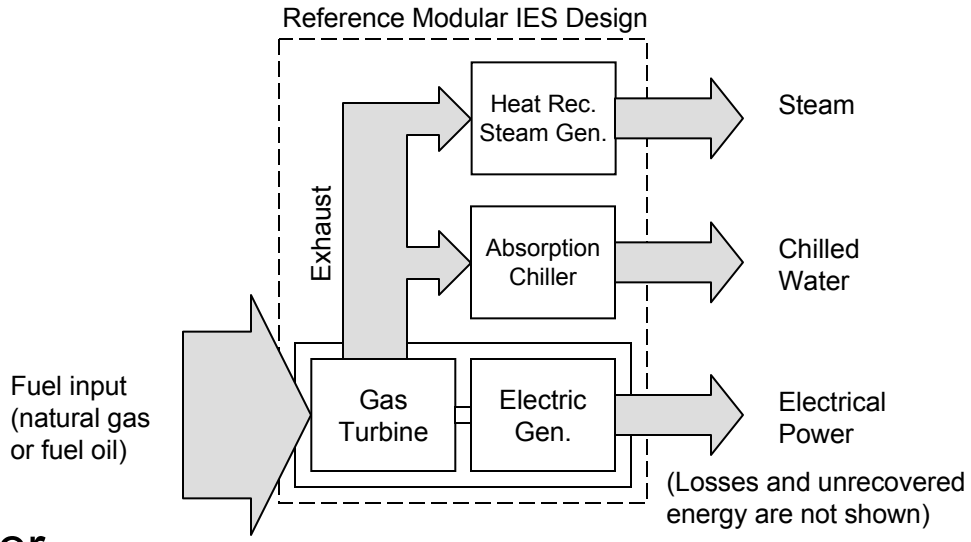
Modular Technology for Large IES Systems

IES Program and Peer Review: May 2, 2002

Project Overview

Objective:

Develop packaging technologies for large (2 to 5 MW) IES systems, and field test a prototype design.



Major equipment:

- Gas turbine generator
- Heat recovery steam generator
- Waste heat fired absorption chiller

Key Goals:

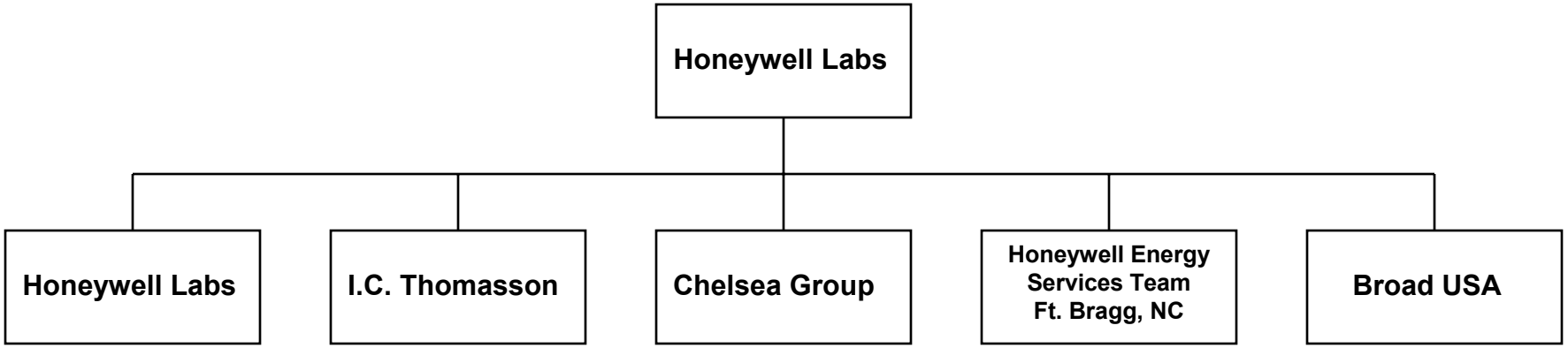
- Develop "reference" CAD-based modular system designs
- Develop a supervisory control system with on-line optimization
- Develop draft Rating Procedures and Standards
- Install and monitor the performance of a prototype IES modular system employing the above technologies

Project Motivations

Project plans to fill technology voids for IES Systems

Technology Void	Proposed Solution	Technical Approach
1. Limited direct reuse of IES system design data	Reference designs to improve economics, and simplify installation	Use industry standards for CAD, and develop templates for performance analysis
2. Limited ability to adapt to changing loads and utility rates	Supervisory control system with on-line optimization	Apply on-line optimization for improved response to varying operating conditions and energy costs

Project Team



Controls & Optimization
Performance Modeling
Project Management

Tim Ruohoniemi: Principal Investigator
Girija Parthasarathy: System Modeling
Julie Hull: Product Definition
Wendy Foslien: Product Definition
Saad Bedros: Control and Optimization
Steve Gabel: Project Manager

IES Reference Designs
Modular Design
Standards Testing

John Wimberly: President
Jay Dyer: Project Engineer
Bob Bratton: CEO

Market Research
Building Interface Definition

Davor Novosel: Principal
George Benda: President

Site Installation
Commissioning
Field Monitoring

Jim Peedin: Account Executive
Bob Moyer: Project Engineer
Greg Robinson: Performance Contract Engineer

Absorption Chiller
Modular Design
Ratings Procedures

Gearoid Foley: Project Manager
Nitin Pathakji: Project Engineer

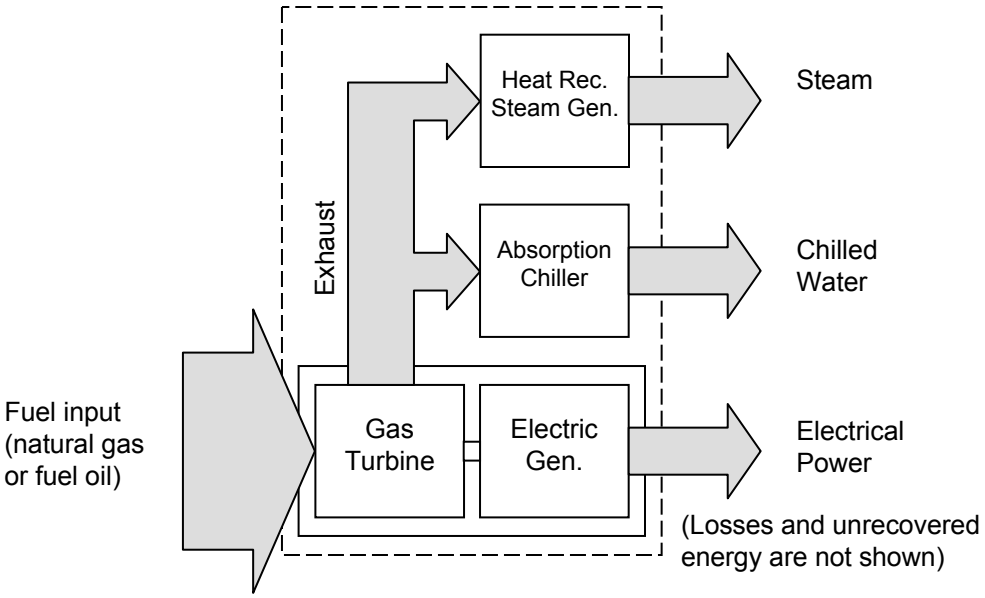
Project Tasks

	Title	Activities
Task 1	Project Plan	Develop project plan
Task 2	Packaged System Concept	Requirements definition Conceptual design Market Assessment
Task 3	Performance Analysis	Analysis of the designs, and field site
Task 4	Rating Procedures and Standards	Develop the standards Prepare draft documentation
Task 5	Prototype Development	Develop reference designs Design and manufacture 1000 ton absorption chiller Develop supervisory control system with on-line optimization Install prototype system at Ft. Bragg, NC
Task 6	Field Monitoring	Monitor performance at Ft. Bragg Reviews and reports

Prototype Development: Reference Designs

Package Reference (CAD) Designs

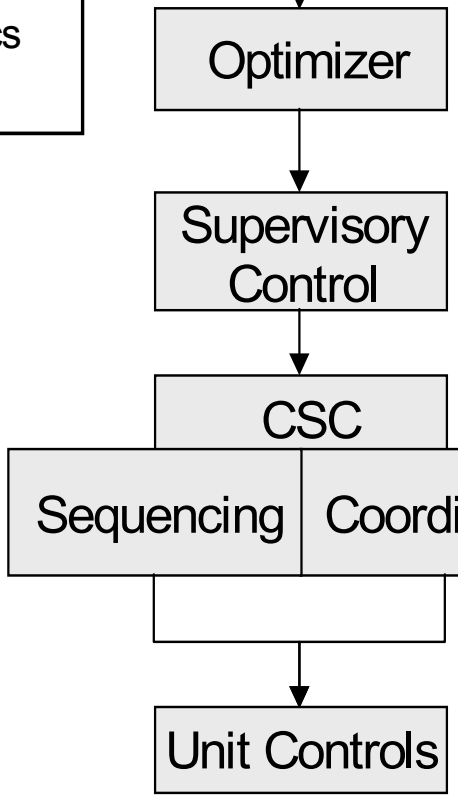
- Schematics and block diagrams
- Top-level CAD drawings (equipment arrangement, interconnection, etc.)
- Key technical and performance specifications
- Templates for analyzing system performance
- Database of example IES designs and application studies



Reference Modular IES Design

Optimization and Supervisory Control

Inputs
- Electric load, heating and cooling loads
- Rates (grid electricity, fuel prices)
- Equipment characteristics
- Weather data



Determine loads to be met by IES equipment, electric grid power, and non-IES equipment

Setpoints for electric power generation, heating output, and cooling output. Load sequencing for multiple energy sources.

Operational sequencing and logic for unit operation (e.g., fuel flow, exhaust flow to HRSG or absorption chiller, etc.)

Coordinate dynamic interaction between different units in order to meet the desired loads

Local control of equipment, supplied with the unit (e.g., chiller) by manufacturer

Absorption Chiller

Broad USA Chiller

- Advanced waste heat fired design
- Nominal capacity: 1000 tons (for Ft. Bragg site)
- Optional direct-fired capability (in the same package) for greater operational flexibility, and chiller-heater arrangement is also available

Ft. Bragg Site Overview

82nd Central Heating Plant:

- Largest central plant on the base, a good application for IES
- Serves barracks and other buildings
- Energy Services Performance Contract proposal by Honeywell Energy Services Team to U.S. Army

- On site power generation and energy recovery to effectively replace poorly performing steam boilers
- 5 MW gas turbine and HRSG are provided by Honeywell Energy Services Team as cost sharing to this DOE IES project
- Showcase CHP project for FEMP, administered by FEMP program office at ORNL

Project Milestones

	Title	Milestone
Task 1	Project Plan	Project plan: Draft (1Q02), Final (2Q02)
Task 2	Packaged System Concept	Technical approach for IES reference designs (3Q02) Conceptual design for control and optimization (3Q02)
Task 3	Performance Analysis	Analysis of the designs (3Q03)
Task 4	Rating Procedures and Standards	Complete the standards (1Q04)
Task 5	Prototype Development	Complete the reference designs (3Q03) Manufacture 1000 ton absorption chiller (3Q03) Develop supervisory control and on-line optimization (3Q03) Install prototype system at Ft. Bragg, NC (3Q03)
Task 6	Field Monitoring	Monitor performance at Ft. Bragg (3Q04)

Project Challenges

Subject	Challenge	Strategy
Reference Designs	Ability to share and disseminate the design data	Utilize a defacto standard (AutoCAD), this can also be imported into most other CAD systems
	Ability of practitioners to re-use design data	Develop templates for the reference designs, and a database of example projects
	Ability to incorporate future improvements in equipment performance	Use heat rate and other performance parameters to characterize the equipment for design and analysis
Control and Optimization	Ability to apply to different IES equipment	Develop generalized equipment models that can be tailored to each site application
	Application of a variety of electric utility rate structures	Use a commercial subscription service to obtain rate data, and perform cost computations

Project Risks

Subject	Risk	Assessment	Remarks
Reference Designs	Reference designs may not apply to a particular site	low risk	Some sites will have unusual requirements, but most sites should be capable of applying a reference design
Control and Optimization	Electric rates may not be available in the subscription service	medium risk	Can hard code the specific rate into the controller, if needed
	Electric and thermal load data may not be available	medium risk	Can manually construct a load history for commissioning, then update on-line

Impacts on DOE IES Program

Expected Results of this Project:

- Use of modular IES reference designs will facilitate wider application of these systems in the buildings sector
- Optimizing the operation of modular IES systems will maximize economic benefits to building owners

Impact on IES Goals:

- Improved energy efficiency for building owners
- Improved energy delivery (on site power generation reduces burden on transmission networks)

Project Summary

Key Project Benefits :

- Improved economics for Modular IES, thru use of reference designs and optimized operation
- Promotes wider use of Modular IES to improve energy efficiency
- Contributes to goals of National Energy Policy:
  - Performance based energy efficiency improvement using public-private partnership
  - Supports Combined Heating, Cooling, and Power